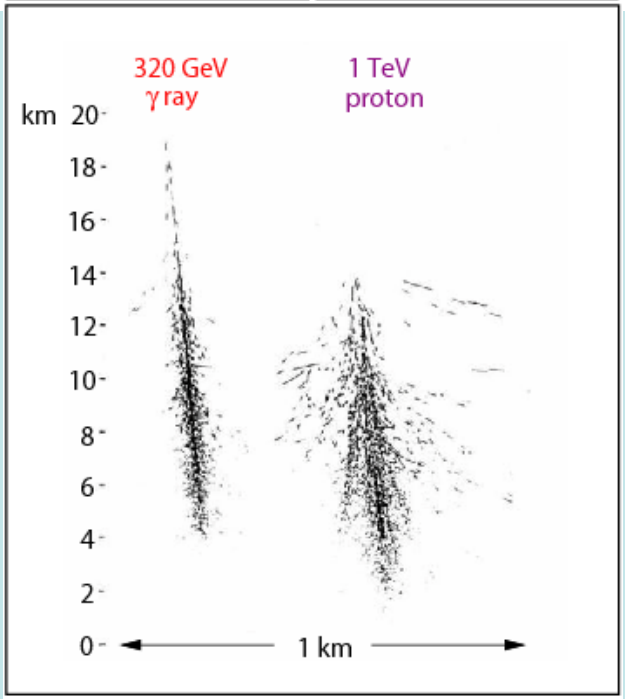
Atmospheric Cherenkov Telescopes

Fermilab

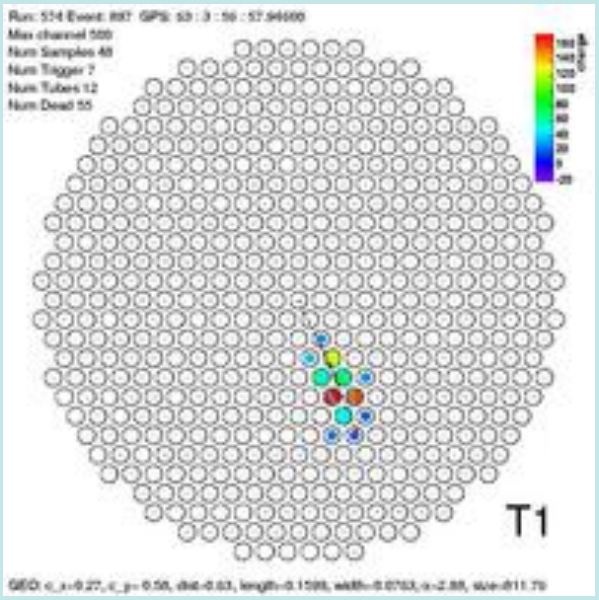
Center for Particle Astrophysics

Method

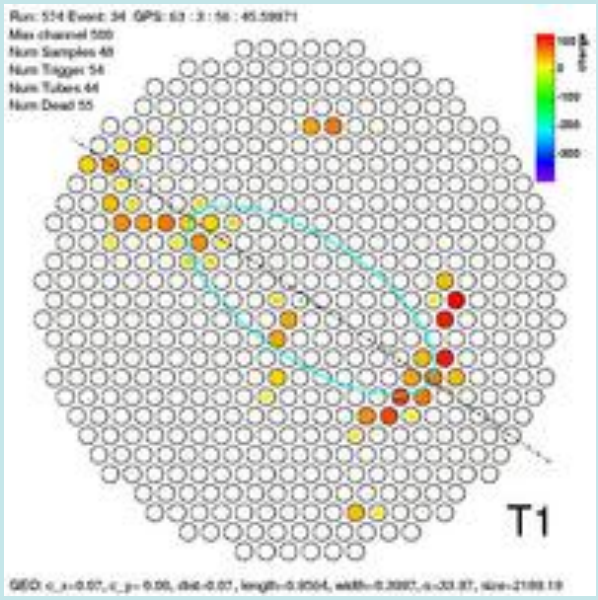
- Imaging Cherenkov light



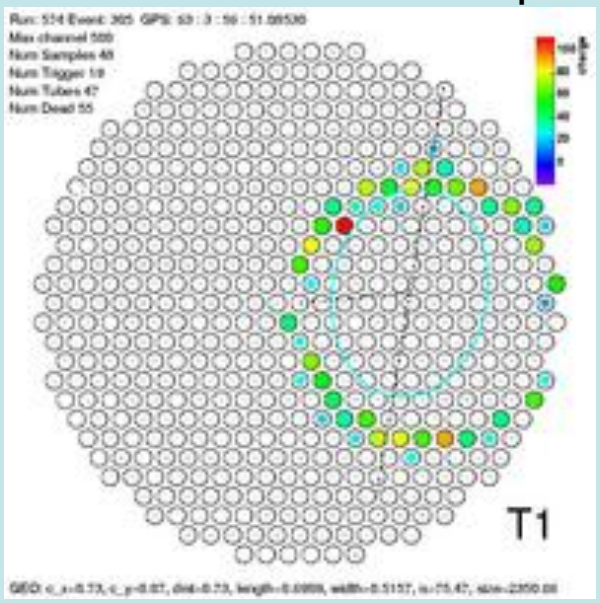
Cherenkov images from VERITAS telescope 1



Electromagnetic shower



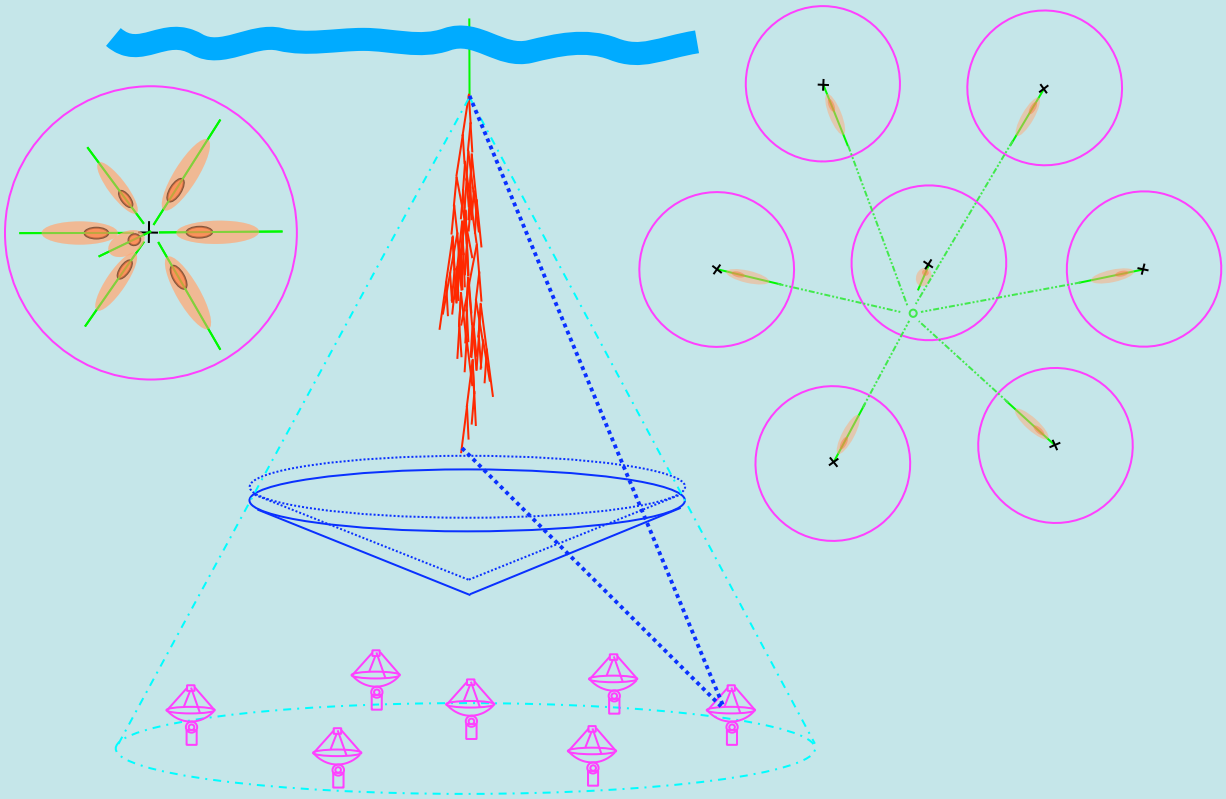
Hadronic shower



Local muon

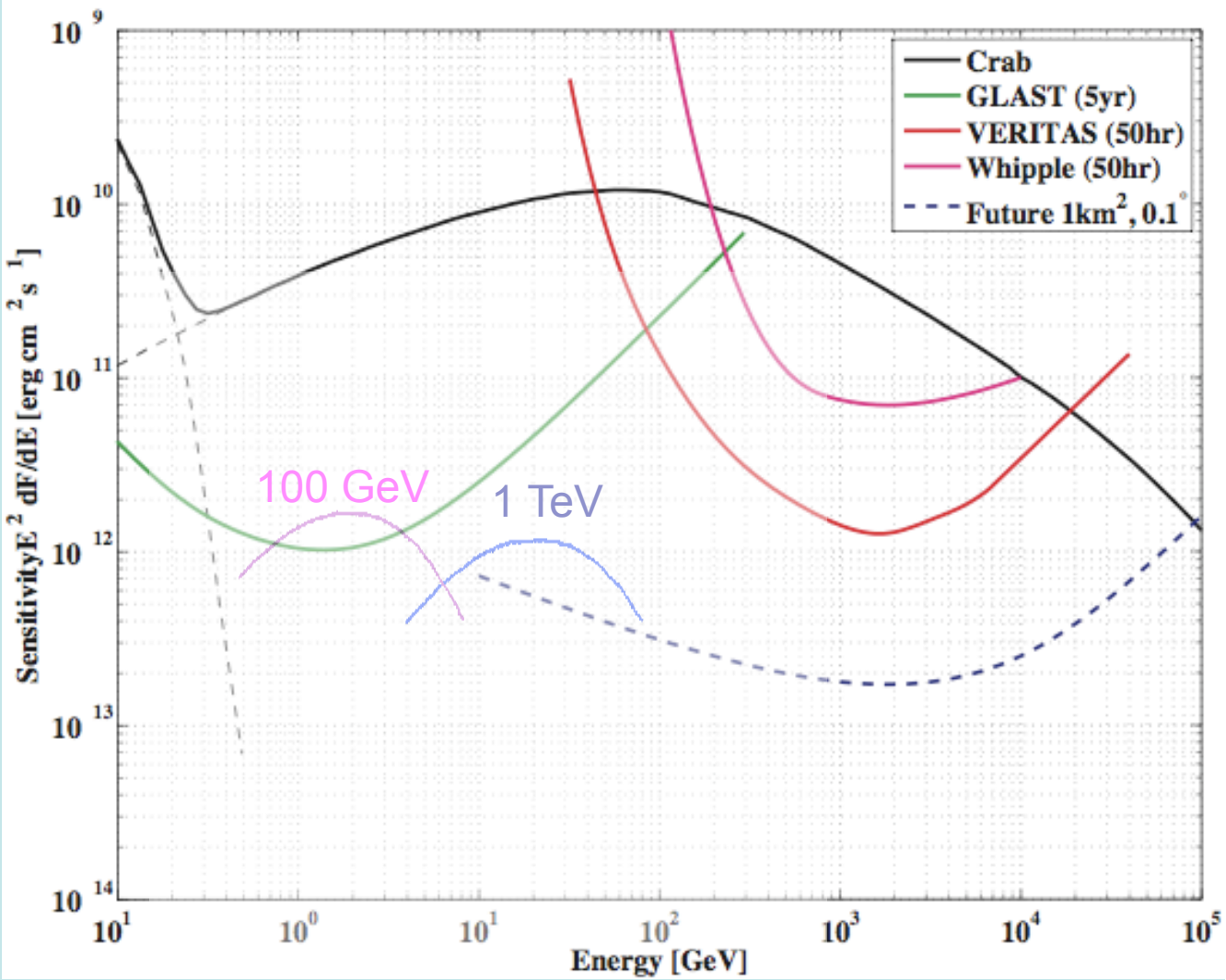
Method

- Imaging Cherenkov light in arrays



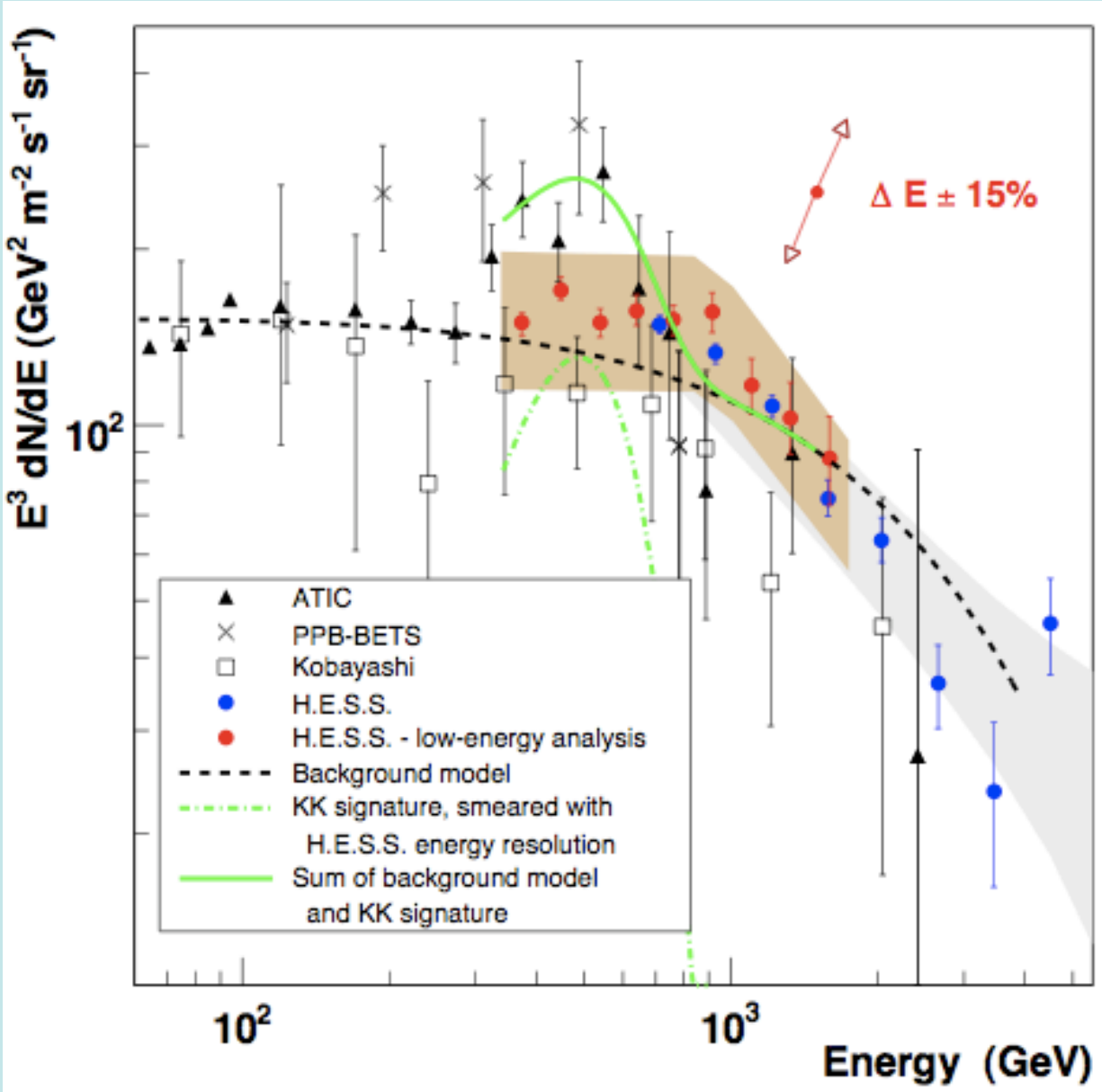
Physics Goals

- Dark Matter



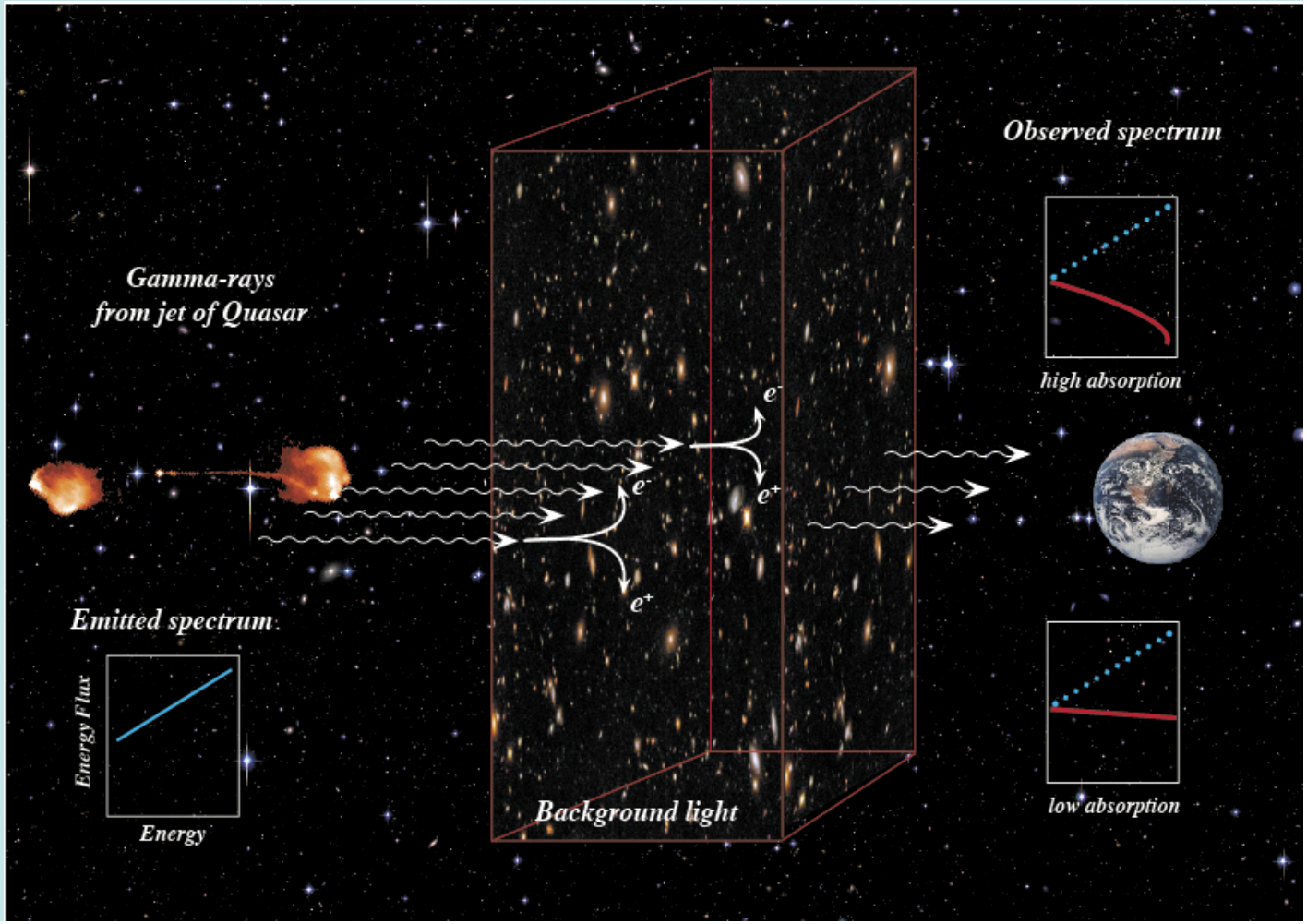
Physics Goals

- Dark Matter



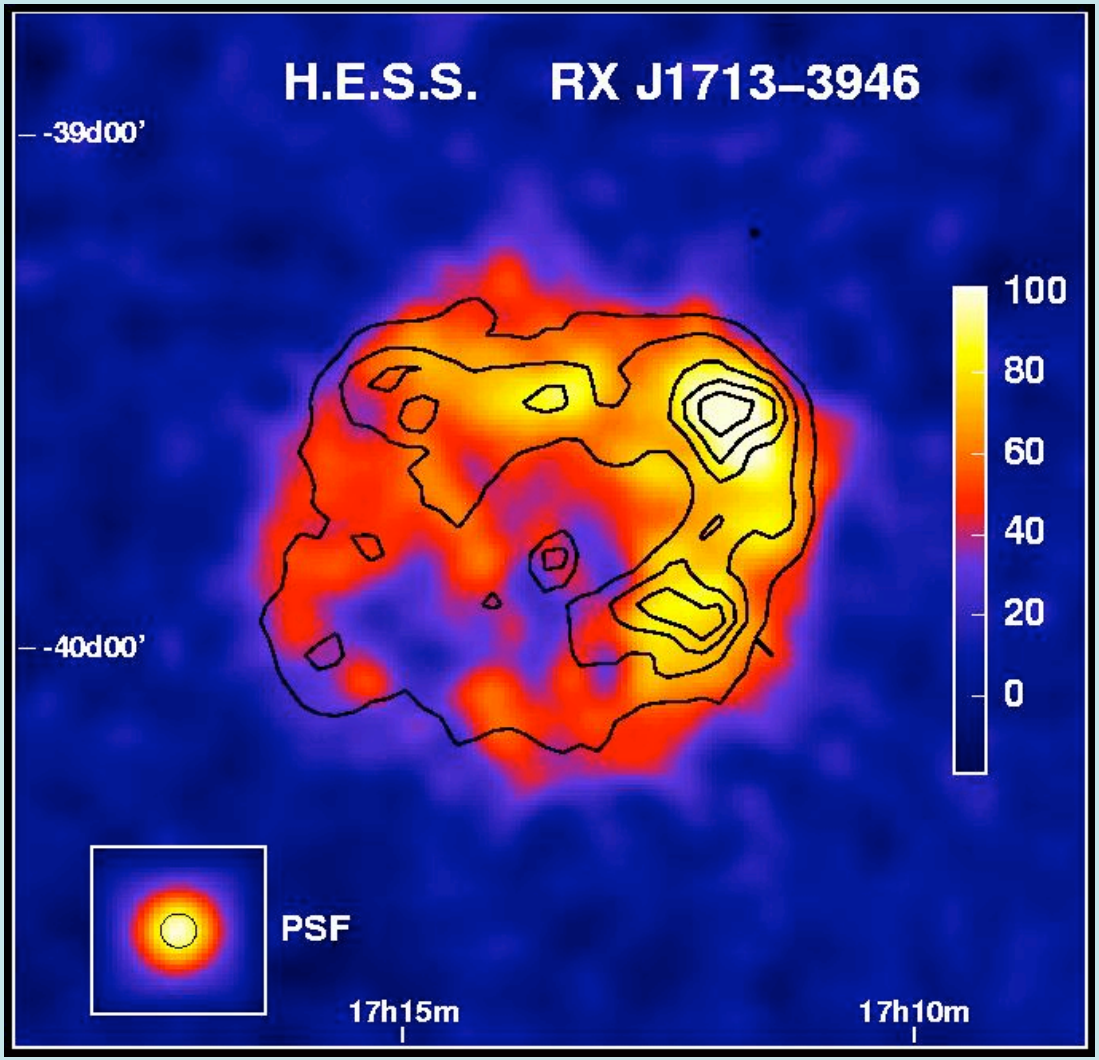
Physics Goals

- Photon Propagation
  - Axions
  - EBL
  - Quantum gravity



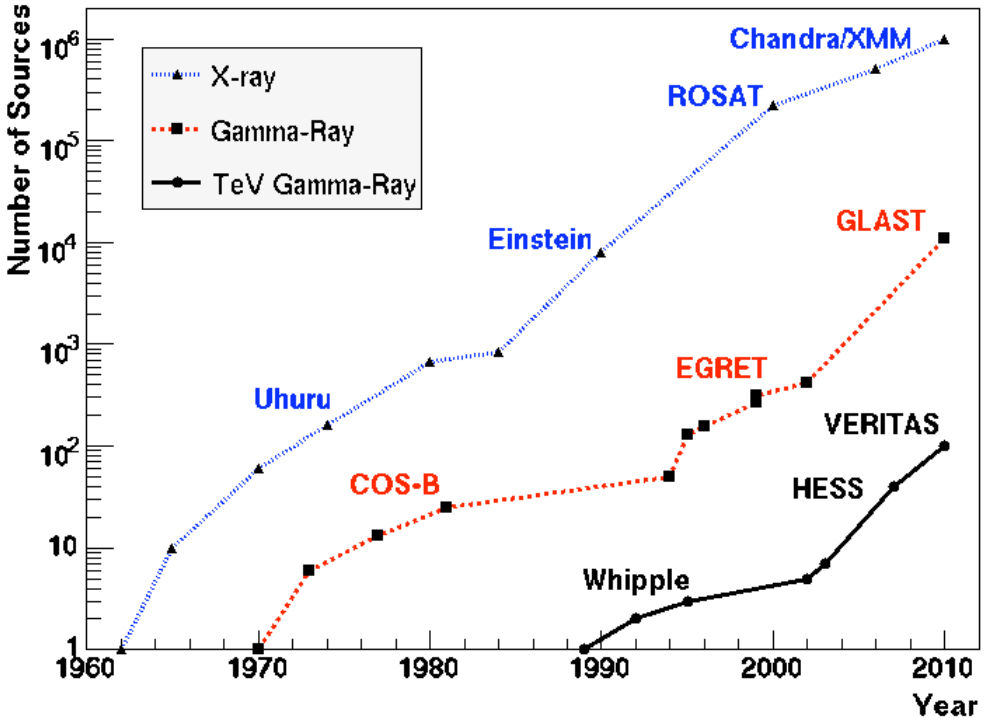
Physics Goals

- Cosmic Radiation



High Impact Science

- Rapidly advancing field
- Next-Gen will enable population studies



High Impact Science

- HESS cost
  20 M Euros

HIGH-IMPACT OBSERVATORIES

Rank	Facility	Citations	Participation
1	SDSS	1892	14.3%
2	Swift	1523	11.5%
3	HST	1078	8.2%
4	ESO	813	6.1%
5	Keck	572	4.3%
6	CFHT	521	3.9%
7	Spitzer	469	3.5%
8	Chandra	381	2.9%
9	Boomerang	376	2.8%
10	HESS	297	2.2%

Key

SDSS - Sloan Digital Sky Survey
HST – Hubble Space Telescope
ESO – European Southern Observatory
CFHT – Canada France Hawaii Telescope
HESS - High Energy Stereoscopic System

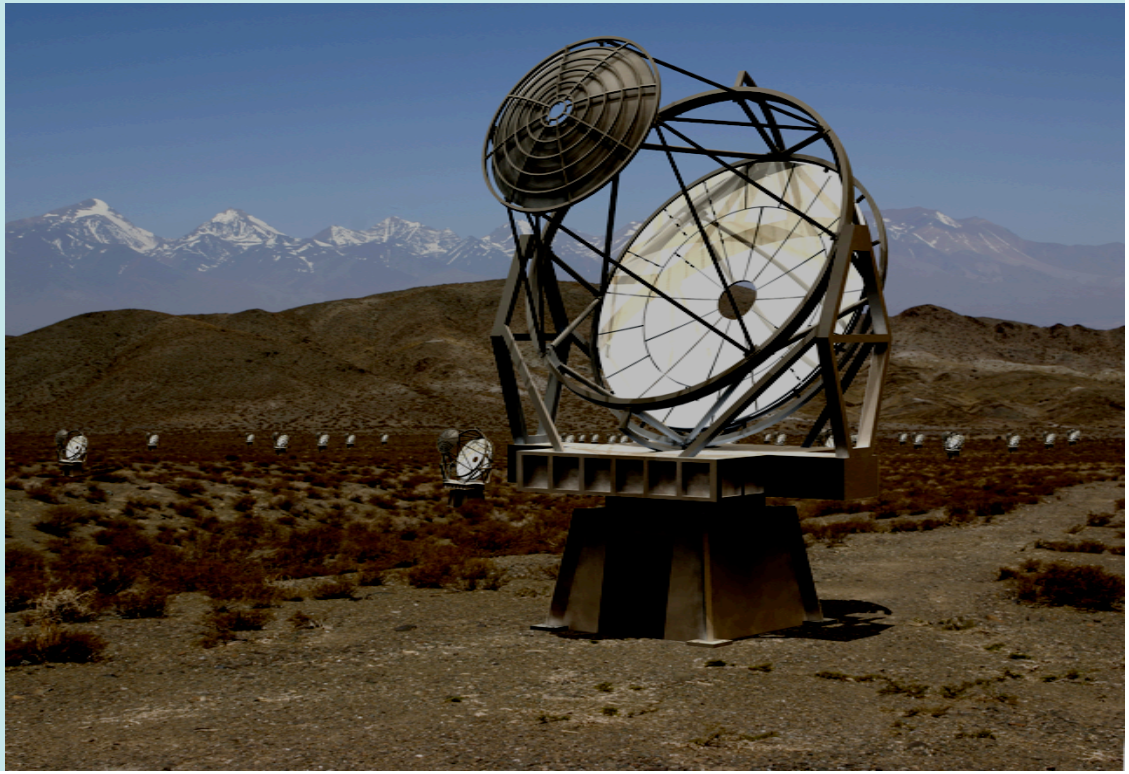
Community

Institutions involved in AGIS:

ADLER	SAO
ANL	Stanford
Barnard	UNAM
Delaware	UCLA
IAFE	UCSC
Iowa State	U. Chicago
LANL	U. Iowa
McGill	Utah
Penn State	Yale
Purdue	Washington U.

DOE was the largest single source of funds for VERITAS

Other major sources of funding included NSF, the Smithsonian, PPARC, SF-Ireland, NSERC



Why Fermilab?

- Imaging Cherenkov light (RICH) is a common technique amongst collider physicists

E-665

SELEX

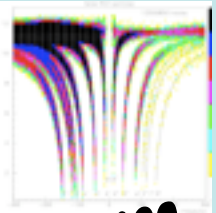
MIPP

BTEV

CKM …

An Overview of RICH Detectors

From PID to Velocity Spectrometers



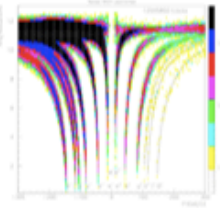
to gamma-ray telescopes

Peter S. Cooper, Fermilab

January 29, 2008

Multi-pixel PMT RICH

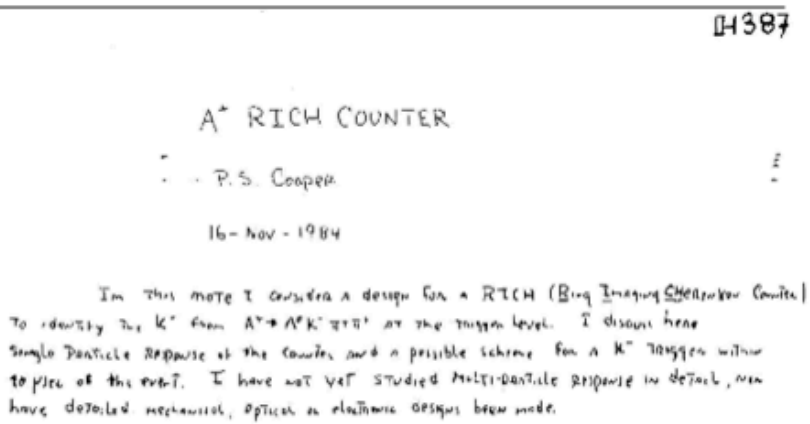
a good, old, idea



Requires

- radiator (usually gas)
- mirror
- position sensitive photon detector (a pmt array)

I designed this one for Selex, the charmed baryon experiment.



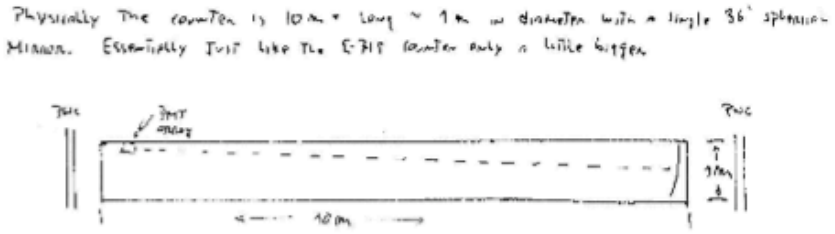
E387

A* RICH COUNTER

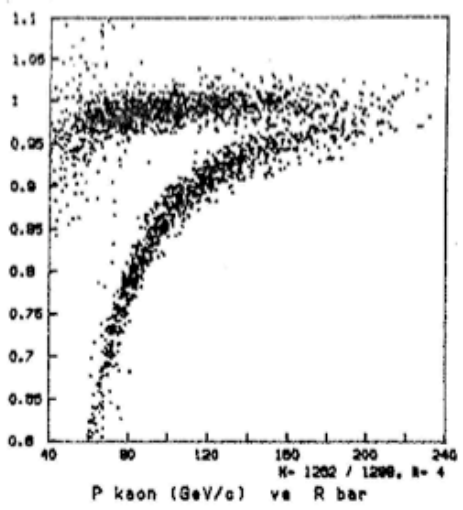
P. S. Cooper

16-Nov-1984

In this note I consider a design for a RICH (Ring Imaging CHerenkov Counter) to identify the K⁻ from $\Lambda_c^+ \to \Lambda^0 K^- \pi^+ \pi^+$ at the trigger level. I discuss here single particle response of the counter and a possible scheme for a K⁻ trigger within 10 μsec of the event. I have not yet studied multi-particle response in detail, nor have detailed mechanical, optical or electronic designs been made.

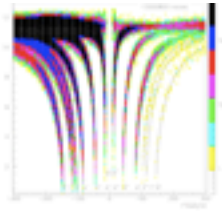


Physically the counter is 10 m long × 1 m in diameter with a single 36' spherical mirror. Essentially just like the E-781 counter only a little bigger.



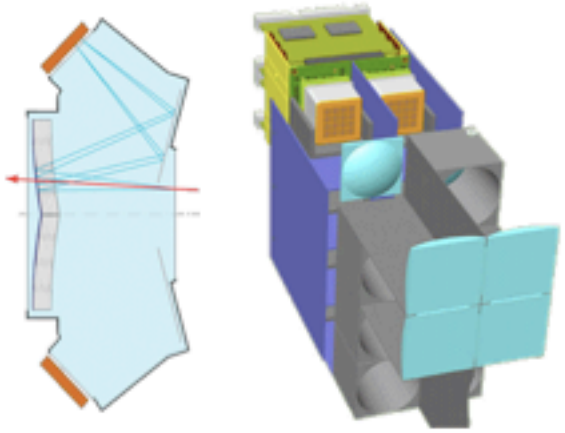
Hera-b RICH

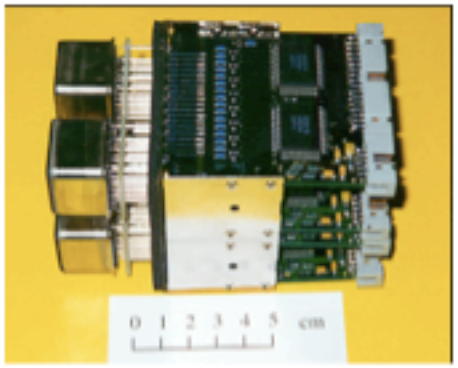
if only the experiment had worked as well as the RICH

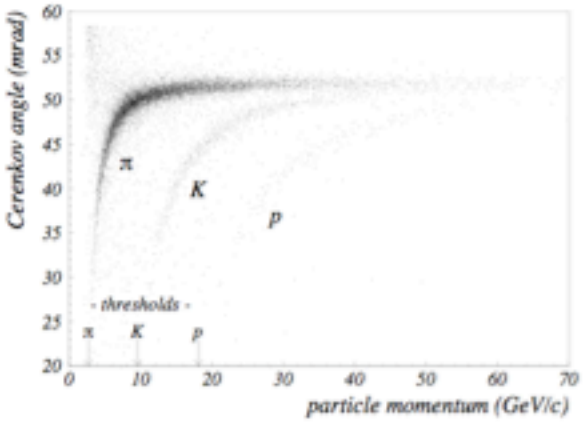


Multi-anode PMTs - the next step

- clever demagnifing lens optics to match Cherenkov photons onto Hammamatsu multi-anode PMTs
- Detector performance goals largely achieved
- The rest of Hera-B had more than a few problems







Why Fermilab?

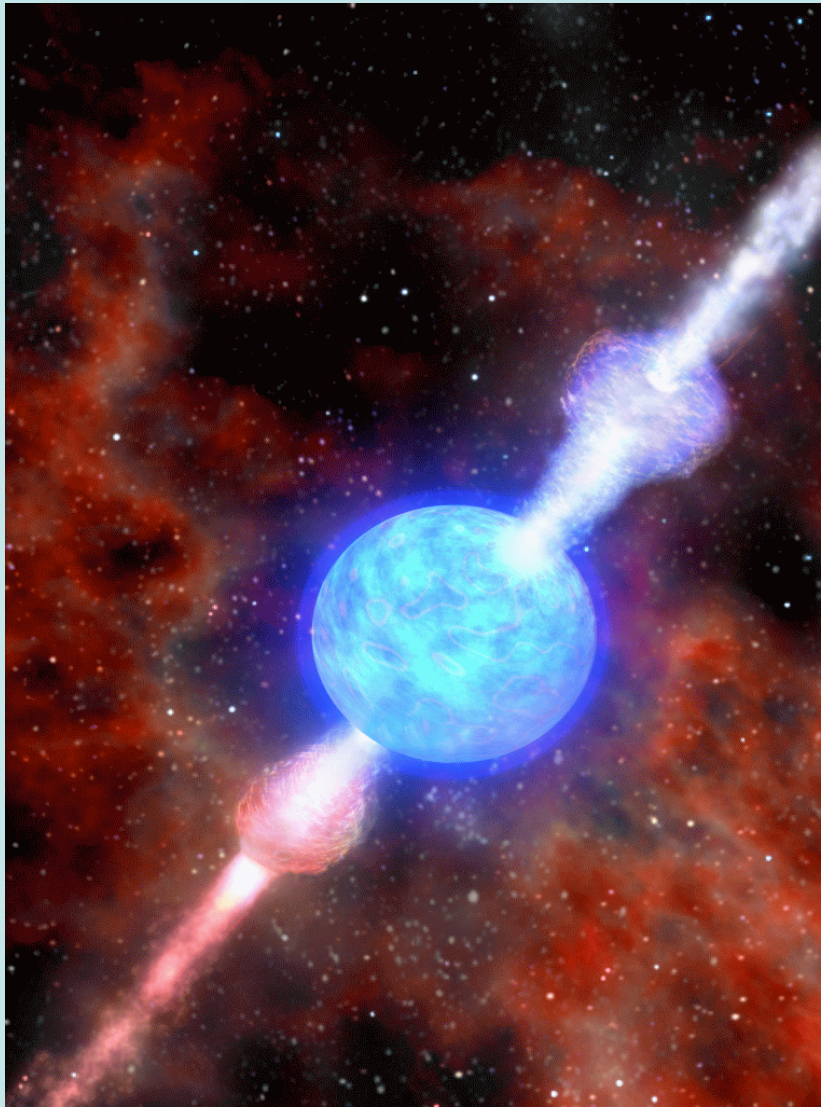
- Data volume will be enormous

Information Technology
(data transfer, reduction, analysis, and storage)

Cosmic ray rate ~10 kHz
64 bytes x 5000 pix x 25 tel x 10 kHz
Raw data rate ~ 80 GB/s x 800 hr
~ 150 PB/year

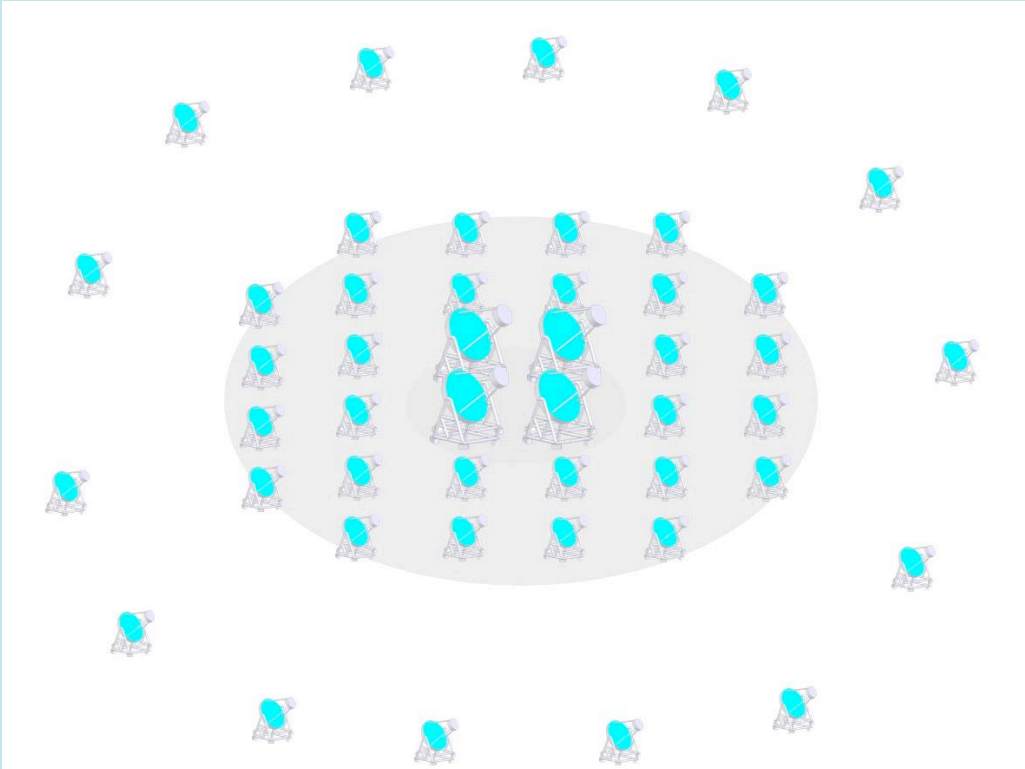
Risks

- Astronomy
  - GRBs
  - Pulsars
  - AGN



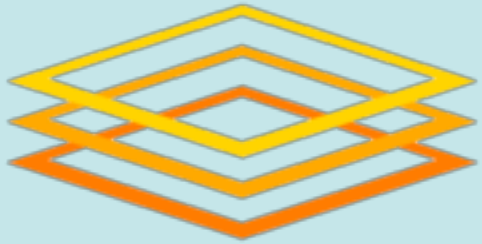
Risks

- Cherenkov Telescope Array (CTA)
  - better organization



A Modest Proposal

- Enable design study for future cherenkov
- Possible purchase modest amount of disk space to cache some results



FermiGrid

Conclusions

- Next-gen ACT observatory will make large impact in both physics and astronomy
- Cost-benefits points to building next observatory quickly
- No large technical barriers, just political organizational and managerial
- Modest investments now can have huge payoff over the next decade